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REMARKS

I. Claim Rejections – 35 U.S.C. § 102

Requirements for Prima Facie Anticipation

A general definition of *prima facie* unpatentability is provided at 37 C.F.R. §1.56(b)(2)(ii):

> A *prima facie* case of unpatentability is established when the information *compels a conclusion* that a claim is unpatentable under the preponderance of evidence, burden-of-proof standard, giving each term in the claim its broadest reasonable construction consistent with the specification, and before any consideration is given to evidence which may be submitted in an attempt to establish a contrary conclusion of patentability. (*emphasis added*)

"Anticipation requires the disclosure in a single prior art reference of each element of the claim under consideration." *W.L. Gore & Associates v. Garlock, Inc.*, 721 F.2d 1540, 220 USPQ 303, 313 (Fed. Cir. 1983) (citing *Soundscriber Corp. v. United States*, 360 F.2d 954, 960, 148 USPQ 298, 301 (Ct. Cl.), *adopted*, 149 USPQ 640 (Ct. Cl. 1966)), *cert. denied*, 469 U.S. 851 (1984). Thus, to anticipate the applicants' claims, the reference cited by the Examiner must disclose each element recited therein. "There must be no difference between the claimed invention and the reference disclosure, as viewed by a person of ordinary skill in the field of the invention." *Scripps Clinic & Research Foundation v. Genentech, Inc.*, 927 F.2d 1565, 18 USPQ 2d 1001, 1010 (Fed. Cir. 1991).

To overcome the anticipation rejection, the Applicant needs to only demonstrate that not all elements of a *prima facie* case of anticipation have been met, *i.e.*, show that the prior art reference cited by the Examiner fails to disclose every element in each of the applicants' claims. "If the examination at the initial state does not produce a prima face case of unpatentability, then without more the applicant is entitled to grant of the patent." *In re Oetiker*, 977 F.2d 1443, 24 USPQ 2d 1443, 1444 (Fed. Cir. 1992).

McHardy

Claims 1, 9-10 and 15 are rejected under 35 U.S.C. 102(b) as being anticipated by McHardy et al. (US Patent 5,315, 162, herein referred to as McHardy). The Examiner suggested that the Applicant review the entire teaching of McHardy, as its entire teachings have been relied upon.

The Applicant has reviewed the entire teachings of McHardy and finds no basis for anticipation of claims 1, 9-20 and 15 by McHardy. Before proceeding with a claim-by-claim discussion of the Examiner's individual claim rejections, the Applicant believes it would be helpfully to actually examiner the McHardy reference and then compare it to Applicant's invention.

The device of McHardy and Applicant's invention are both used in the context of microelectronic networks. This is, however, where the similarity ends. The following discussion is intended to illustrate, in the most direct and simplest way possible, the significant differences between McHardy and Applicant's invention. The following discussion is intended as a systematic deconstruction of the McHardy device and Applicant's invention and is meant as a way to illustrate the many and significant differences between these two devices. The Applicant will begin with a short description of each device.

The McHardy Device

The McHardy device is a chemical device whose foundation is the process of electroplating. The McHardy device requires four basic circuit elements to function:

1. DC voltage source
2. Migratable metal
3. Non-Migratable metal
4. Permanent interconnect.

These components can be seen in Figure 1 below:

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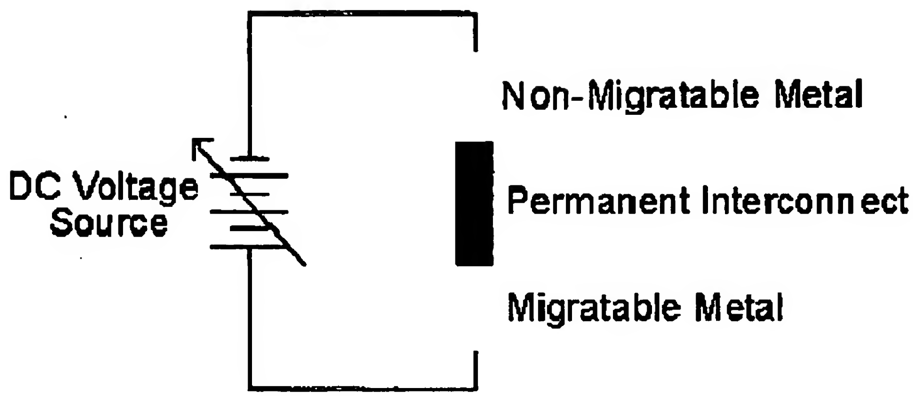

Figure 1

For the McHardy synapse to function, the materials that compose the device must display very particular properties with the Applicant will now explain.

Migratable metal—according to McHardy, many forms of metals can be considered "migratable" including silver, copper, bismuth, cadmium, tin, and lead. In the context of the McHardy synapse, a metal is considered migratable if an ion can be produced in the presence of a moisture film and a voltage source so that the metal ion can move or *migrate* through the moisture film.

Non-Migratable metal—As one might suspect, a non-migratable metal is a metal that does not dissolve in the presence of a moisture film and applied voltage. According to McHardy, non-migratable metals include gold, indium, palladium and platinum.

Permanent Interconnect—According to the McHardy patent, the permanent interconnect can take one of two forms. First, the permanent interconnect may be composed of carbon with an absorbed moisture film on the surface of the carbon interconnect (e.g., see claim 6 of McHardy). Second, it may

PAGE 10/64 * RCVD AT 12/18/2006 2:50:34 PM [Eastern Standard Time] * SVR:USPTO-EFXRF-3/9 * DNIS:2738300 * CSID:5053141307 * DURATION (mm-ss):17-54

be composed of mixed halides of rubidium with copper or silver (e.g., see claim 7 of McHardy).

The purpose of the permanent interconnect is to facilitate the conduction of ***ions*** through or across the material. As the ions precipitate to atoms ***on or in*** the material, they form conducting filaments that bridge the pre- and post-synaptic (anode and cathode) terminals. This process is directly related to electroplating.

The process of metal migration and deposition used in the McHardy synapse is illustrated in Figure 2 below:

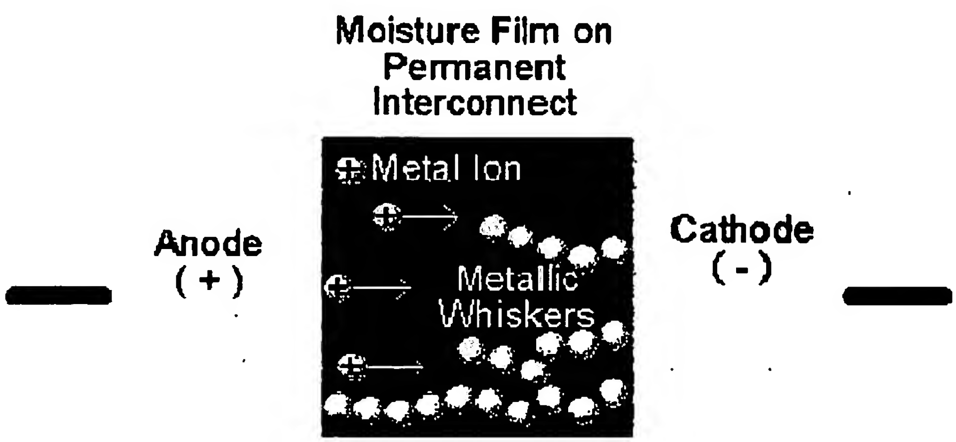

Figure 2

As detailed by McHardy (i.e., see C1, L45-55 of McHardy), metal migration takes place between conductors in an active electronic circuit in the presence of a moisture film. Under the influence of a DC voltage, metal ions dissolve from the positive conductor (the anode). The ions migrate through the moisture film (the electrolyte) and plate out on the negative conductor (the cathode). The deposit often takes the form of metallic whiskers which eventually reach the anode and create an ohmic contact.

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Applicant's Invention

Applicant's invention essentially utilizes 4 basic circuit elements to function:

1. Voltage source (AC or DC)
2. Pre-synaptic and post-synaptic electrodes (any conductive substance)
3. Non-electrically conductive viscous solution (liquid dielectric)
4. Electrically conductive (preferably charge-neutral) nanoparticles

An illustrative example of Applicant's invention is shown in Figure 3 below.

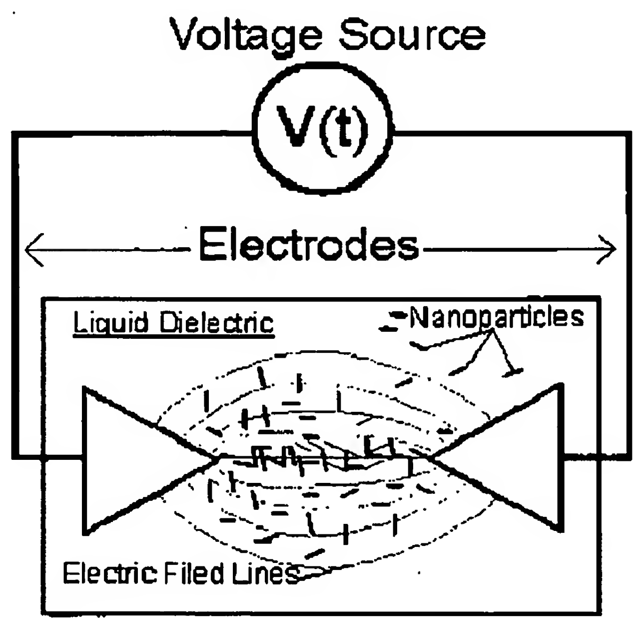

Figure 3

The operation of Applicant's invention is as follows. Pre-synaptic and post-synaptic electrodes (shown as gold/yellow in Figure 3 above) are charged with a voltage source. This voltage may be DC or AC, though AC is preferred. The applied voltage generates an electric field between the electrodes. The region between the

electrodes is comprised of a liquid dielectric and nanoparticles. The inhomogeneous electric field generates a dipole in the nanoparticles. The dipole induced force, which results from the interaction of the applied electric field with the dipole, draws the nanoparticles into the region between the electrodes. The accumulation of nanoparticles between the electrodes facilitates the electrical conduction between the electrodes. The physical process of moving particles with a dipole-induced force is "dielectrophoresis" or "DEP". A short discussion of DEP is provided below. Applicant's specification also indicates the use of dielectrophoresis. For example, Applicant's paragraph [00271] teaches "...The tip of the growing nanowire creates local electric fields of high intensity and gradient, giving rise to a dielectrophoretic force, which causes the aggregation." The general topic of dielectrophoresis is also discussed in some of the references included in Applicant's IDS (information disclosure statement).

Dielectrophoresis

The use of nanoparticles (e.g., nanoconductors) in a dielectric solution and exposed to electric fields as taught by Applicant's invention is based on the scientific principals of dielectrophoresis. The concept of dielectrophoresis or DEP was presented in the following article, which was submitted with Applicant's original Information Disclosure Statement (IDS):

Hermanson et al., "Dielectrophoretic Assembly of Electrically Functional Microwires from Nanoparticle Suspensions," Materials Science, Vol. 294, No. 5544, Issue of 2 Nov 2001, pp. 1082-1086

The concept of dielectrophoresis is additionally discussed in the following paper, which was also included as a part of Applicant's original IDS submission:

Smith et al., "Electric-field assisted assembly and alignment of metallic nanowires," Applied Physics Letters, Vol. 77, No. 9, 28 August 2000, pp. 1399-1401

In order to understand Applicant's invention, however, the Applicant believes that a short discussion of the concept of dielectrophoresis would be helpful to the Examiner.

When a nanoconductor is suspended in a dielectric liquid medium and subjected to an electric field, the electric field induces a polarization in the nanoconductor. If the field is homogeneous, the induced dipole aligns in the direction of the field. If the field is inhomogeneous, the nanoconductor will feel a force. The direction of the force is determined by the dielectric properties of the nanoconductors and the suspension. If the nanoconductor is more polarizable than the surrounding medium, the nanoconductor will feel a force in the direction of increasing field gradient, which is termed **positive DEP** (pDEP). On the other hand, **negative DEP** (nDEP) results when the medium is more polarizable than the particle. At low frequencies, charge accumulation at the nanoconductor/medium boundary contributes to the induced dipole, which is referred to as the **Maxwell-Wagner Interfacial Polarization** and is a function of the nanoconductor used and the medium conductivities. As the frequency is increased, this term of the polarization has increasingly less of an effect, as mobile charges do not have time to move an appreciable distance. For the case of a spherical particle or nanoconductor, the time-averaged DEP force is given by:

$$\bar{F}_{dep} = 2\pi r^3 \varepsilon_0 \varepsilon_m \,\mathrm{Re}\left[\frac{\varepsilon_p^* - \varepsilon_m^*}{\varepsilon_p^* + 2\varepsilon_m^*}\right]\nabla E^2$$

Equation 1

For any geometry other than a sphere or ellipsoid, an analytical derivation of the DEP force is not trivial, and the applicability of Equation 1 requires the particle (nanoconductor) radius to be small compared to the changes in the gradient of the

energy density (∇E^2). This is certainly not the case for Applicant's synapse geometries, as the nanoparticle/nanoconductor will be of equal magnitude to the inter-electrode spacing. For the case of coplanar electrodes, finite element simulation has found that the maximum DEP force occurs when the particle radius is on the same order as the electrode width. A general conclusion is that the force calculated from Equation 1 will give an underestimate of about 20%, as the equation does not include higher-order moments that become increasingly important for large bead sizes.

It is evident from Equation 1 that the DEP force is dependant on real part of the **Clausius-Mossotti (CM) Factor**

$$\frac{\varepsilon_p^* - \varepsilon_m^*}{\varepsilon_p^* + 2\varepsilon_m^*}$$

Equation 2

The value of the CM factor determines the sign of the force. For positive values, the force is directed along the direction of maximum field gradient. The CM factor is determined by the particle and mediums complex permittivity, which can be expressed as,

$$\varepsilon^* = \varepsilon - \frac{\sigma}{\omega} i$$

Equation 3

where σ is the conductivity of the material. Equation 3 warrants special attention. The relative permittivity and conductivity of the bead and the medium determines a cross over frequency, where the DEP force transitions from positive

DEP to negative DEP. This can be seen in Figure 5 below for latex beads in methanol.

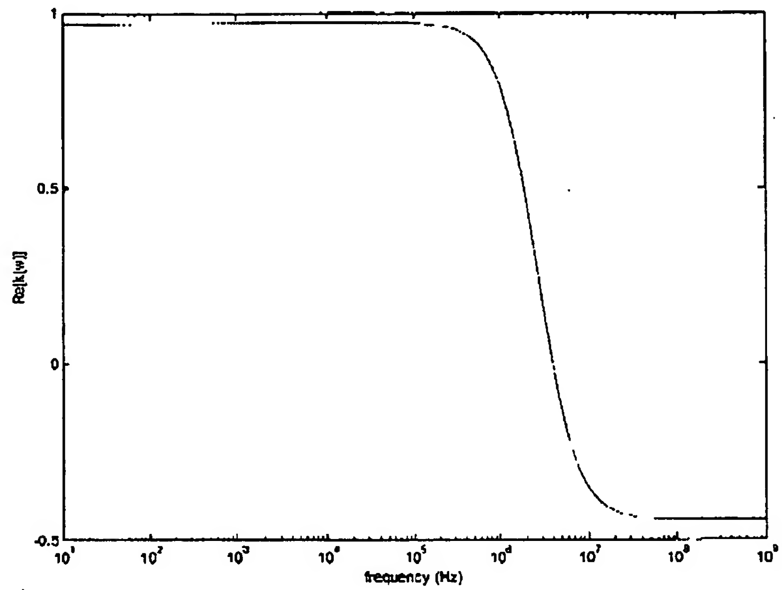

Figure 5

Real Part of the Clausius-Mossotti Factor, the frequency-dependant term in **Equation 1**, showing the cross-over between positive and negative DEP

The transition from positive DEP to negative DEP is dependant on the conductivity of the bead and medium. The real part of the CM factor is given by:

$$\mathrm{Re}[CM] = \left[\frac{(\varepsilon_p - \varepsilon_m)(\varepsilon_p + 2\varepsilon_m) - \frac{1}{\omega^2}(\sigma_m - \sigma_p)(\sigma_m + \sigma_p)}{(\varepsilon_p + 2\varepsilon_m)^2 + \frac{1}{\omega^2}(\sigma_m + \sigma_p)^2} \right]$$

Equation 4

One can see that as the frequency is increased, the conductivity becomes increasingly insignificant. The crossover frequency can be found from Equation 4 and is given by:

$$\omega = \sqrt{\frac{(\sigma_m - \sigma_p)(\sigma_m + \sigma_p)}{(\varepsilon_p - \varepsilon_m)(\varepsilon_p + 2\varepsilon_m)}}$$

Equation 5

Figure 6 shows the cross over frequency plotted against the medium conductivity.

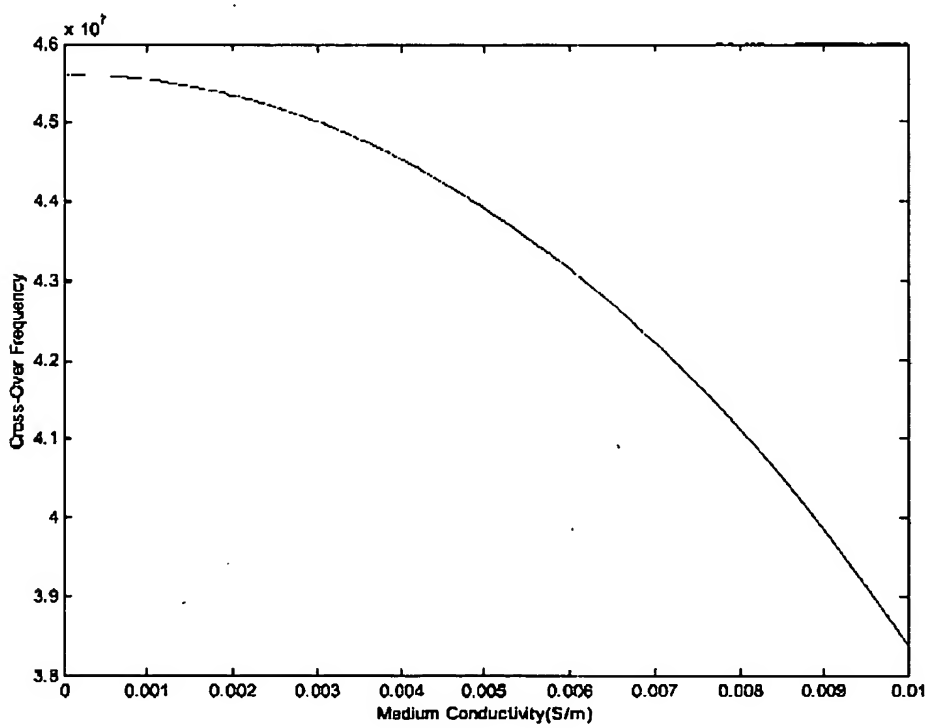

Figure 6

Cross Over Frequency vs. Medium Conductivity for Latex Beads

The phenomenon of dielectrophoresis (e.g., positive DEP and negative DEP) thus can be used by Applicant's invention as an electromechanical mechanism for both attracting and repelling nanoconductors from the electrode gap (i.e., Applicant's "connection gap"). This provides the ability to both strengthen and weaken one or more synaptic components, such as those described in Applicant's invention. As in almost all physical models, there is the first-order theory, and then there are the second order effects. Some of these effects included variations in polarizibility from non-spherical nanoparticles/nanoconductors and low-frequency charge accumulation and a resulting field cancellation, among others.

Device Differences

As stated before, both the device of McHardy and Applicant's invention are intended as a micro-fabricated artificial synapses and that is where the similarity ends. The McHardy device and Applicant's invention, however, operate on completely different physical processes. This fundamental difference is obvious to many. However, the subject matter is difficult and new, so it has become clear that what may be obvious to some may not be obvious others. This section is intended to compare some of the ways the devices are different so as to aid the patent examiner in understanding the underlying physics of the two devices.

Summary of Significant Differences

1. Use of permanent interconnect versus non-use
2. Electrochemical versus electromechanical
3. DC voltage versus AC voltage
4. Metal ions versus conductive nanoparticles
5. Use of Migratable metals versus non-use

Use of permanent interconnect (McHardy) versus non use (Applicant's Invention).

As stated previously and illustrated in Figure 1 and the McHardy Patent, **the McHardy synapse requires a permanent interconnect** between the anode and

cathode to facilitate the migration of metal ions from the migratable metal to deposition on the interconnect. The use of this permanent interconnect is fundamental to the operation of the McHardy synapse is explicitly explained throughout the McHardy patent and in all claims.

Applicant's invention requires no permanent interconnect. Instead, a dipole-induced force, positive dielectrophoresis, attracts nanoparticles (not limited metal ions) to regions of high energy density, concentrating in the particles in regions where the electric field is highly divergent. The DEP process might seem confusing for the patent examiner not familiar with the principles of dielectrophoresis. The interested reader can find numerous textbooks, scientific papers and websites dedicated to the process of dielectrophoresis and a short description has been provided in this document. A general informative web site on the topic of dielectrophoresis can be accessed for free on the Internet at the following URL:

http://www.foresight.org/Conference/MNT7/Papers/Hughes/index.html

The Applicant invites the Examiner to review this web site for general information regarding dielectrophoresis.

***Electro*chemical *versus Electro*mechanical**

The McHardy synapse utilizes a chemical process to achieve connection variation. The chemical process is fundamental to the operation of the McHardy device and is described in detail throughout the McHardy patent and stated as a limiting aspect of the McHardy invention in every single claim of McHardy. The balancing electrochemical reactions are shown clearly (see for example, C5 L40-65 of McHardy) and make use of the pH changes at the anode and cathode by the electrolysis of water.

By stark contrast, the Applicant's invention is electro*mechanical*. No chemical bonds are broken nor made during device operation. The dipole-induced

force acts to accumulate particles between electrodes to facilitate electrical conduction. Although Applicant's connection could be built with water, the electrolysis that make the McHardy synapse viable could degrade Applicant's synapse by creating hydrogen and oxygen gas. In all likelihood, water will not be used in Applicant's synapse. Substances like ethanol, methanol, and toluene are more likely candidates.

DC voltage versus AC voltage

The McHardy synapse requires a DC voltage for operation. The electrochemical process can only function in a condition of known DC bias. Indeed, electro migration cannot be defined without reference to a DC bias. Chemical reactions occur on the *anode* and *cathode*. Reversal of the DC bias changes the operational characteristic of the device.

Applicant's synapse, again in stark contracts to the McHardy synapse, is not dependant on voltage polarization. A dipole-induced force is independent of voltage polarization. Applicant's synapse utilizes a voltage bias across a connection to attract nanoparticles to an electrode gap via positive DEP and uses negative DEP to disperse the nanoparticles. See earlier discussion regarding these two competing forces.

Metal ions versus conductive nanoparticles

The McHardy synapse requires the formation of metal ions. In this respect, it is absolutely critical that one of the electrodes of McHardy be of a type that will permit this process, what McHardy refers to a "Migratable Metal". The metal atom must attain charge by losing electrons on a moisture film. The charged atom then feels an electrostatic force, which pulls it toward the cathode where it regains its electrons and is deposited on a permanent interconnect. The function of this devise is not defined without the present of charged metal atoms or ions.

In stark contrast to the McHardy synapse, Applicant's synapse does not require metal ions. The principles that makes Applicant's synapse operational, (e.g., dipole-induced force / dielectrophoresis) does work on charged particles. However, it is advantageous that a particle be charge-neutral so that the only appreciable force felt by the particle is the dielectrophoretic force which will tend to accumulate the particles only between the electrodes rather than the all over the anode or cathode. All of this goes without saying that a conductive nanoparticle or nanoconductor, as described by the Applicant's invention, is not the same as a metal ion. Applicant's invention operates with molecular structures (i.e., nanoconductors) such as DNA or carbon nanotubes, accumulations of elementary material like gold nanoparticles or nanowires, substances such as, for example, latex nano-spheres or complex particles comprising combinations of many types of molecules or atoms, and not simply "ions".

Use of Migratable metals versus non-use

The McHardy synapse requires that a synapse be constructed from two types of metals forming the pre- and post-synaptic electrode terminals. One metal much be a "migratable" metal and the other must be a "non-migratable" metal. McHardy defines a migratable metal as a metal that will form ions in the presence of an electrolyte and an applied voltage. The McHardy synapse is not defined outside of the scope of a device constructed entirely from non-migratable metal. McHardy lists gold as one type of non-migratable metal.

In stark contrast, Applicant's synapse does not require a distinction between migratable and non-migratable metals. Applicant's invention can be constructed entirely on non-migratable metals because its operation is not dependant on metal ions and the effects of electroplating.

Applicant's invention does not require the use of migratable metals as defined by McHardy's electrochemical processes. In fact, McHardy states clearly that gold is

a non-migratable metal (i.e., see Col. 3, line 68), whereas with Applicant's invention, gold nanoparticles, for example, can be used in a dielectric solution to form a synapse.

Claims 1, 17

The Examiner asserted that McHardy anticipates a physical neural network based on nanotechnology comprising (the Examiner cited McHardy, C 1-6, particularly C 1, L 8-10; also C 2, L 45-54; the Examiner argued that ¶ 14 applies; from specification @ p22:1-3, the Examiner also argued "nanoconductor ... nanotechnology .. can be implemented as a molecule or groups of molecules"), a dipole-induced comprising a connection network (the Examiner cited McHardy, Figs. 1, 2; dipole is two poles; neural networks are "inherently" a connection network, and asserted that as proper operation requires numerous weighted connections and other requirements) comprising a plurality of electrically conducting nanoconnections suspended and free to move about in a dielectric liquid solution located within a connection gap (the Examiner cited McHardy, C 3, L 43-62; Fig. 1) formed between at least one input electrode and at lease one output electrode (the Examiner cited McHardy, C 1-6, particularly C 1, L 44 through C 2, 54 where it discusses the roles of the anode and the cathode), wherein at least one nanoconnection of said plurality of conducting nanoconnections within said dielectric liquid solution can be strengthened or weakened according to an application of an electric field across said connection gap (the Examiner cited McHardy, C 1-6, particularly C 1, L 44 through C 2, 54; also C 3, L 44 through C 4, L 7; strengthening or weakening corresponds to the amount of whiskers present in the interconnect channel, likewise the conductivity of that channel) and a plurality of physical synapses of said physical neural network formed from said electronically conducting nanoconnections of said connection network (the Examiner cited McHardy, C 1-6, particularly C 2, L 45-54).

The Applicant respectfully disagrees with this assessment and refers the Examiner to the discussion provided earlier distinguishing McHardy from Applicant's invention. Additionally, the Applicant notes that McHardy does not teach, disclose or suggest "nanotechnology" as taught by Applicant's invention. The Examiner cited C 1, L 8-10 and C 2, L 45-54 of McHardy and also asserted that ¶ 14 of McHardy Applies from specification @ p22:1-3. The Examiner additionally argued "nanoconductor ... nanotechnology .. can be implemented as a molecule or groups of molecules". C1, L8-10 of McHardy cited by the Examiner as basis for establishing a disclosure by McHardy of "nanotechnology" states the following: "More particularly, the present invention relates to solid state, adjustable weight synapses for controlling the interaction of neurons..." There is no reference or teaching here of nanotechnology and additionally this language indicates that McHardy is a solid state device.

As indicated previously, Applicant's claims relate to the use of a liquid dielectric solution. The solid in the "solid-state" device of McHardy is not a liquid. C2, L45-54 of McHardy cited by the Examiner indicates the following: "...in accordance with the present invention, electrochemical synapses are provided for use in neural networks wherein the electrochemical synapses are solid state devices which are well suited for miniaturization to provide the extremely large number of synapses which are required for a neural network." Again, there is no disclosure here of nanotechnology as that term is taught by Applicant's invention and is generally known in the art. The use of the word "miniaturization" does not necessarily mean "nanotechnology" as taught by Applicant's invention. Although the whiskers of McHardy are small, it is not clear how the "whiskers" of McHardy constitute a nano-scale component. There are any number of miniaturized devices, which are not nanoscale-based devices. Additionally, this language cited by the Examiner again refers to solid-state (as distinguished from the use of Applicant's liquid) and also refers to the use of "electrochemical" components (as distinguished

from Applicant's electromechanical-based device, i.e., see previous discussion above with respect to McHardy and electrochemical versus electromechanical.)

Regarding the concept of "nanotechnology" as taught by Applicant's invention, the Applicant believes it would be helpful to the Examiner to understand what is meant by the term "nanotechnology" as taught by Applicant. A general discussion of "nanotechnology" is provided in Applicant's "background" section as follows:

"The term "Nanotechnology" generally refers to nanometer-scale manufacturing processes, materials and devices, as associated with, for example, nanometer-scale lithography and nanometer-scale information storage. Nanometer-scale components find utility in a wide variety of fields, particularly in the fabrication of microelectrical and microelectromechanical systems (commonly referred to as "MEMS"). Microelectrical nano-sized components include transistors, resistors, capacitors and other nano-integrated circuit components. MEMS devices include, for example, micro-sensors, micro-actuators, micro-instruments, micro-optics, and the like.

In general, nanotechnology presents a solution to the problems faced in the rapid pace of computer chip design in recent years. According to Moore's law, the number of switches that can be produced on a computer chip has doubled every 18 months. Chips now can hold millions of transistors. It is, however, becoming increasingly difficult to increase the number of elements on a chip utilizing existing technologies. At the present rate, in the next few years the theoretical limit of silicon-based chips will have been attained. Because the number of elements and components that can be manufactured on a chip determines the data storage and processing capabilities of microchips, new technologies are required for the development of higher performance chips.

Present chip technology is also limited in cases where wires must be crossed on a chip. For the most part, the design of a computer chip is limited to two dimensions. Each time a circuit is forced to cross another circuit, another layer must be added to the chip. This increases the cost and decreases the speed of the resulting chip. A number of alternatives to standard silicon based complementary metal oxide semiconductor ("CMOS") devices have been proposed. The common goal is to produce logic devices on a nanometer scale. Such dimensions are more commonly associated with molecules than integrated circuits.

The issue of interconnects in neural network hardware poses a serious problem. Because of the massive interconnectivity, a neural network constructed with standard integrated electronic methods can never reach the desired neuron and synapse density, simply because the interconnections overwhelm the largely 2-diminsional chip. It can thus be appreciated that almost any sort of 3-diminsional connectivity, no matter how simple, could offer tremendous benefits.

Integrated circuits and electrical components thereof, which can be produced at a molecular and nanometer scale, include devices such as carbon nanotubes and nanowires, which essentially are nanoscale conductors ("nanoconductors"). Nanoconductors are tiny conductive tubes (i.e., hollow) or wires (i.e., solid) with a very small size scale (e.g., 0.7 to 300 nanometers in diameter and up to 1mm in length). Their structure and fabrication have

been widely reported and are well known in the art. Carbon nanotubes, for example, exhibit a unique atomic arrangement, and possess useful physical properties such as one-dimensional electrical behavior, quantum conductance, and ballistic electron transport.

Carbon nanotubes are among the smallest dimensioned nanotube materials with a generally high aspect ratio and small diameter. High-quality single-walled carbon nanotubes can be grown as randomly oriented, needle-like or spaghetti-like tangled tubules. They can be grown by a number of fabrication methods, including chemical vapor deposition (CVD), laser ablation or electric arc growth.

Carbon nanotubes can be grown on a substrate by catalytic decomposition of hydrocarbon containing precursors such as ethylene, methane, or benzene. Nucleation layers, such as thin coatings of Ni, Co, or Fe are often intentionally added onto the substrate surface in order to nucleate a multiplicity of isolated nanotubes. Carbon nanotubes can also be nucleated and grown on a substrate without a metal nucleating layer by using a precursor including one or more of these metal atoms. Semiconductor nanowires can be grown on substrates by similar processes.

The aforementioned language generally describes what is meant by "nanotechnology" and describes the context of Applicant's invention. Of course, it is understood by those who work with the nanotechnology arts that variations to the aforementioned description and examples are like to arise, but this description can be utilized as a general guideline for the context of "nanotechnology" in which Applicant's invention is provided.

Thus, the nanoconductors of Applicant's invention represent nanoscale conductors such as nanotubes, nanowires, nanoparticles and even DNA. For example, Applicant's paragraph 0087 indicates the following:

Nanoconductors can be provided in a variety of shapes and sizes without departing from the teachings herein. A nanoconductor can also be implemented as, for example, a molecule or groups of molecules. A nanoconductor can also be implemented as, for example, DNA.

A nanoconductor as taught by Applicant's invention is thus a multi-atom structure such as a nanotube, a nanowire, DNA, etc., and not atoms and ions. Atoms and ions, for example, are simply just that...i.e., atoms and ions. The Applicant's use of nanotechnology-based devices and components relates to multi-atom structures that are built (man-made or natural) or synthesized. DNA, for example, is a naturally constructed multi-atom structure. Free floating ions and atoms utilized for example in the context of common P-well and N-well

configurations are not such structures. Atoms and atomic ions do not represent nanoparticles/nanoconductors because "nanotechnology" seeks to use atoms as the building blocks of multi-atom structures.

Additionally, nanotechnology implies the use of devices or components that are nanometer-scale in dimensions. There is no indication of any nanometer-scale dimensions in McHardy.

Regarding the claim limitation of a dipole-induced connection network, the Examiner referred to FIGS. 1-2 of McHardy and stated that a "dipole is two poles". FIGS. 1-2 clearly do not illustrate a dipole-induced connection network. Additionally, the statement that a "dipole is two poles" does not provide any basis for asserting that McHardy teaches a dipole-induced connection network. The Applicant again refers the Examiner to the discussion provided earlier with respect to what is meant by dipole-induced:

> "...The region between the electrodes is comprised of a liquid dielectric and nanoparticles. The inhomogeneous electric field generates a dipole in the nanoparticles. The dipole induced force, which results from the interaction of the applied electric field with the dipole, draws the nanoparticles into the region between the electrodes. The accumulation of nanoparticles between the electrodes facilitates the electrical conduction between the electrodes. The physical process of moving particles with a dipole-induced force is generally referred to as "dielectrophoresis" or "DEP".

The statement that a "dipole is two poles" and the reference to FIGS. 1-2 of McHardy clearly does not anticipate the dipole-induced connection network of Applicant's invention and the use of dielectrophoresis, that is the physical process of moving particles with a dipole-induced force as explained previously.

Regarding the Applicant's claim limitations of a plurality of electrically conducting nanoconnections suspended and free to move about in a dielectric liquid solution within a connection gap, the Examiner cited McHardy, C3, L 43-62 and FIG. 1 of McHardy in support of this argument. C3 L43-62 of McHardy states the following:

"The present invention involves solid-state, electrochemical synapses which are adapted for use in neural networks. A preferred exemplary electrochemical synapse in accordance with the present invention is shown generally at 10 in FIG. 1. The electrochemical synapse includes an input terminal 12, an output terminal 14, and a permanent interconnect 16 located therebetween. The permanent interconnect 16 forms an electrolytic path between the input terminal 12 and output terminal 14. The permanent interconnect has a small, but finite conductivity. The input terminal 12 and output terminal 14 are spaced apart a distance of less than 100 microns. Preferably, the spacing between the input terminal 12 and output terminal 14 will be on the order of 5-10 microns. A DC voltage is provided across the permanent interconnect 16 by voltage source 18 which is connected to the input terminal 12 and output terminal 14 by way of electrical connections 20 and 22, respectively."

This language of McHardy cited by the Examiner does not provide any disclosure and anticipation of the dielectric liquid solution of Applicant's invention and electrically conducting nanoconnections that are suspended and free to move about in the dielectric liquid solution. What aspect of this language of McHardy or any other aspect of McHardy constitutes a dielectric liquid solution? Additionally, it also significant to note that this language of McHardy also refers to the permanent interconnect and an electrolytic path. The Applicant earlier discussed the permanent interconnect and how it is different from Applicant's invention. Additionally, the use of an electrolytic path implies the use of electrolytic materials rather than dielectric materials. An electrolytic medium is not the same as a dielectric medium.

An electrolytic medium is not a dielectric medium: one exists for the movement of ions to promote electrical conduction (electrolytic); the other is used specifically for its properties of canceling electric fields and inhibiting electrical conduction (dielectric). An electrolytic medium involves the use of an electrolyte and not a dielectric. McHardy provides no teaching, suggestion or disclosure of the use of such a dielectric medium. Conductors referred to by McHardy do not constitute a dielectric solvent. Additionally, the moisture film of McHardy is not a dielectric medium. McHardy is based on the electrolytic path (interconnect 16) and hence an electrolyte, not a dielectric.

An electrolyte is a substance containing free ions which behaves as an electrically conductive medium. A dielectric, on the other hand, is basically an electrical insulator, and constitutes a substance that is highly resistant to electric current. Unlike an electrolyte, a dielectric tends to concentrate an applied electric field within itself. As the dielectric interacts with the applied electric field, charges are redistributed within the atoms or molecules of the dielectric. This redistribution alters the shape of the applied electric field both inside and in the region near the dielectric material. It is this process, when taken with the affects of nanoparticles also displaying a dielectric behavior, which causes a dipole-induced force to attract the particles to the connection gap. This is in fact the entire basis of the scientific principal of dielectrophoresis and is the electromechanical process described by Applicant's invention (as opposed to the electrochemical device of McHardy).

A dielectric medium is not an electrolytic medium. In fact, the use of an electrolyte teaches away from a dielectric and such materials that concentrate an applied electric field within itself. The electrolytic path of the permanent interconnect 16 of McHardy is simply not a dielectric medium as taught by Applicant's invention. The electrolytic path of McHardy extends from the anode to the cathode. In Applicant's invention, on the other hand, there is no such "path" because the nanoparticles are pulled into the electrode gap (i.e., connection gap) from the surrounding dielectric solution and not from the anode.

McHardy also provides no teaching, disclosure or hint of the use of a dielectric medium and dielectrophoresis in the context of actual physical neural networks as taught by Applicant's invention.

The Examiner also cited C 1-6 of McHardy and C1 L44 through C 2 54 regarding the anode and cathode of McHardy. The Applicant again notes that there is no electrolytic "path" in Applicant's invention because the nanoparticles are pulled into the electrode gap (i.e., connection gap) from the surrounding dielectric solution and not from the anode. It is significant to note that on C1 L44-45, McHardy states

that "...metal migration is an electrochemical process related to electroplating". Applicant's invention does not require nor is based on electroplating as taught by McHardy. Additionally, C 2, lines 4-5 of McHardy refers to the "medium" in which McHardy's whisker growth takes place. This medium of McHardy is not a dielectric liquid solution. This is also true with respect to C 1-6 and C 1, L44 through C 2 54 and C3 L44 through C4 L 7 of McHardy cited by the Examiner with respect to the rejection to claims 1 and 17.

Based on the foregoing, it is clear that McHardy does not provide for all of the claim limitations:

A physical neural network based on nanotechnology comprising:

a dipole-induced connection network comprising a plurality of electrically conducting nanoconnections suspended and free to move about in a dielectric liquid solution located within a connection gap formed between at least one input electrode and at least one output electrode, said plurality of electrically conducting nanoconnections comprising a plurality of nanoconductors suspended in said dielectric liquid solution, said plurality of nanoconductors subject to a dielectrophoretic force resulting from an exposure to an electric field, whereby said dielectrophoretic force is utilized to attract or repel said plurality of nanoconductors to said connection gap formed between said at least one input electrode and said at least one output electrode;

wherein at least one nanoconnection of said plurality of electrically conducting nanoconnections within said dielectric liquid solution can be strengthened or weakened according to an application of said electric field across said connection gap; and

a plurality of physical synapses of said physical neural network formed from said electrically conducting nanoconnections of said connection network.

Based on the forgoing, it can be appreciated that the rejection against claims 1 and 17 fails under the aforementioned prima facie anticipation test. That is, in order to comply with the prima facie anticipation test, the rejection used as a basis for a rejection under 35 U.S.C. 102 must disclose each and every claim limitation of the rejected claim. If even one claim limitation, however minor, is not disclosed by the cited reference (in this case McHardy) then the rejection to the claim at issue based on the cited reference fails and must be withdrawn.

The Applicant therefore submits that the rejection to claims 1 and 17 has been traversed. The Applicant respectfully requests withdrawal of the aforementioned to rejection to claims 1 and 17 under 35 U.S.C. 102.

Claim 9

The Examiner argued that McHardy anticipates the physical neural network of claim 1 wherein said at least one input electrode comprises a pre-synaptic electrode and said at least one output electrode comprises a post-synaptic electrode (the Examiner cited McHardy, C 1-6, particularly C 3, L 44-62).

The Applicant respectfully disagrees with this assessment and submits that the arguments presented above against the rejection to claims 1 and 17 apply equally against the rejection to claim 9. McHardy at C 1-6 and particularly C 3, L 44-63 does not teach, disclose or suggest all of the claim limitations of Applicant's claims 2 and claim 9. C 3, L 44-63 of McHardy provides no disclosure of dielectrophoresis, a dipole-induced connection network, a dielectric medium, nanoconductors disposed in a connection gap in the dielectric medium, and so forth. The Applicant therefore submits that the rejection to claim 9 has been traversed. The Applicant respectfully requests withdrawal of the aforementioned rejection to claim 9 under 35 U.S.C. 102.

Claim 10

The Examiner asserted that McHardy anticipates the physical neural network of claim 9 wherein a resistance of said electrically conducting nanoconnections bridging said at least one pre-synaptic electrode and said at least one post-synaptic electrode is a function of a prior electric field across said at least one pre-synaptic electrode and said at least post-synaptic electrode (the Examiner cited McHardy, C 1, L 29 through C 2, L 4, where it discusses Bernard Widrow's "memistor's" capability to regulate resistance through the application of an electric field and also

immediately following this discussion where it describes the process of metal migration, and how metallic whiskers grow to create an ohmic [resistive] contact between electrodes when a DC voltage is applied, the whiskers being the molecular conducting connections).

The Applicant respectfully disagrees with this assessment and submits that the arguments presented above against the rejection to claims 1 and 17 apply equally against the rejection to claim 10. Additionally, McHardy at C 1, L 29 through C 2, L 4 provides no teaching of wherein a resistance of said electrically conducting nanoconnections bridging said at least one pre-synaptic electrode and said at least one post-synaptic electrode is a function of a prior electric field across said at least one pre-synaptic electrode and said at least post-synaptic electrode. There is no disclosure or teaching of the prior electric field feature of Applicant's claim 10 in McHardy at C 1, L 29 through C 2, L 4. Additionally, Applicant's invention, as indicated previously, is not based on the use of metal migration. Also, McHardy at C 1, L 29 through C 2, L 4 does not provide any disclosure of dielectrophoresis, a dipole-induced connection network, a dielectric medium, nanoconductors disposed in a connection gap in the dielectric medium, and so forth. The Applicant therefore submits that the rejection to claim 10 has been traversed. The Applicant respectfully requests withdrawal of the aforementioned rejection to claim 10 under 35 U.S.C. 102.

Claims 15, 19, 22

The Examiner argued that McHardy anticipates two electrode arrays aligned perpendicular to each other, wherein at least one of said at least two electrode arrays comprises said one input electrode and at least one other of said at lease two electrode arrays comprises said at least one output electrode (the Examiner cited McHardy, Fig. 1, C 3, L 44-62; ¶ 14. applies; applicant's arrays can be circular

arrays that have a many faceted orientation to include perpendicular, such orientation is also achieved by McHardy in Fig. 1).

The Applicant respectfully disagrees with this assessment and submits that the arguments presented above against the rejection to claims 1 and 17 apply equally against the rejection to claims 15, 19, 22. As such, McHardy does not provide any disclosure of dielectrophoresis, a dipole-induced connection network, a dielectric medium, nanoconductors disposed in a connection gap in the dielectric medium, and so forth. Additionally, McHardy does not provide for any disclosure of two electrode arrays aligned perpendicular to each other, despite the citation of Fig. 1, C 3, L 44-62 and ¶ 14 of McHardy. FIG. 1 of McHardy does not illustrate perpendicular electrode arrays. Fig. 1, C 3, L 44-62 and ¶ 14 of McHardy also do not provide any illustration or disclosure of perpendicular arrays. This feature is simply not disclosed by McHardy. FIG. 1 of McHardy does not even illustrate an array of any type, let alone or two arrays arranged perpendicular to each other. Similarly, C 3, L 44-62 and ¶ 14 of McHardy provides no disclosure of "two arrays arranged perpendicular to each other" let alone arrays of any type.

The Applicant therefore submits that the rejection to claims 15, 19, and 22 has been traversed. The Applicant respectfully requests withdrawal of the aforementioned rejection to claims 15, 19, and 22 under 35 U.S.C. 102.

Claim 23

The Examiner asserted that McHardy anticipates nanoconnections among said plurality of electrically conducting nanoconnections comprise a plurality of interconnected nanoparticles (the Examiner cited McHardy, C 4 L 8-45; and stated that from specifications @ p22:1-3, nanoconductor ... nanotechnology .. can be implemented as a molecule or groups of molecules; a metal whisker qualifies.) The Applicant respectfully disagrees with this assessment and submits that the arguments presented above against the rejection to claims 1 and 17 apply equally

against the rejection to claim 23. As such, McHardy does not provide any disclosure of dielectrophoresis, a dipole-induced connection network, a dielectric medium, nanoconductors disposed in a connection gap in the dielectric medium, and so forth. McHardy, and particularly C 4 L 8-45, does not provide any disclosure hint or suggestion of nanoconnections among said plurality of electrically conducting nanoconnections comprise a plurality of interconnected nanoparticles based on the use of dielectrophoresis, a dipole-induced connection network, a dielectric medium, nanoconductors disposed in a connection gap in the dielectric medium, and so forth. The Applicant therefore submits that the rejection to claim 23 has been traversed. The Applicant respectfully requests withdrawal of the aforementioned rejection to claim 23 under 35 U.S.C. 102.

II. *Claim Rejections – 35 USC § 103*

Prima Facie Obviousness

The obligation of the examiner to go forward and produce reasoning and evidence in support of obviousness is clearly defined at M.P.E.P. §2142:

> The examiner bears the initial burden of factually supporting any *prima facie* conclusion of obviousness. If the examiner does not produce a *prima facie* case, the applicant is under no obligation to submit evidence of nonobviousness.

M.P.E.P. §2143 sets out the three basic criteria that a patent examiner must satisfy to establish a *prima facie* case of obviousness:

1. some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings;
2. a reasonable expectation of success; and
3. the teaching or suggestion of all the claim limitations by the prior art reference (or references when combined).

It follows that in the absence of such a *prima facie* showing of obviousness by the Examiner (assuming there are no objections or other grounds for rejection), an applicant is entitled to grant of a patent. *In re Oetiker*, 977 F.2d 1443, 1445, 24 USPQ2d 1443 (Fed. Cir. 1992). Thus, in order to support an obviousness rejection, the Examiner is obliged to produce evidence compelling a conclusion that each of the three aforementioned basic criteria has been met.

McHardy in view of Gorelik

The Examiner rejected claims 2-8 under 35 U.S.C. 103(a) as being unpatentable over McHardy as applied to claim 1 above, and further in view of Gorelik (US Patent No. 5,864,835, herein referred to as Gorelik).

Claim 2

Regarding claim 2, the Examiner admitted that McHardy fails to teach wherein the physical neural network further comprises a gate located adjacent said connection gap, insulated from electrical contact by an insulation layer.

The Examiner asserted that Gorelik teaches wherein the physical neural network further comprises a gate located adjacent said connection gap, insulated from electrical contact by an insulation layer (Gorelik: ¶ 14. applies; C 8 L 54 through C 9, L 35).

The Examiner also asserted that being from the same field of endeavor, physical neurons (of artificial neural systems) and synapses thereof mimic the behavior of biological neurons, and that it would have been obvious to one of ordinary skill at the time of applicant's invention to combine McHardy's electrochemical synapse which provides easy miniaturization of the vast amounts of neurons needed to simulate biological neurons with Gorelik's semiconducting method of an approximation to an artificial biological neuron with this insulation layer so as to maintain charge within the charge carrying layer indefinitely, thus

allowing minimal leakage. (the Examiner cited Gorelik: C 8 L 54 through C 9, L 35) The Examiner argued that combining the electrochemical synapse with a semiconducting signaling device allows for greater flexibility in the application of the physical neural network, where it is to be implemented in different environments for different needs of fault-tolerance or physical structure or electrical requirements.

The Applicant respectfully disagrees with this assessment and submits that the arguments presented above against the rejection to claims 1 and 17 under 35 U.S.C. 102 apply equally against the rejection to claim 2 under 35 U.S.C. 103 based on McHardy/Gorelik. There are several reasons why Gorelik cannot properly be combined with McHardy as argued by the Examiner. First, the Examiner asserted that Gorelik is from the same field of endeavor as McHardy. The Applicant asserted earlier that McHardy does not teach, disclose or suggest nanotechnology as taught by Applicant's invention. Second, even if, however, McHardy does teach nanotechnology, it is clear that Gorelik does not teach nanotechnology and in fact teaches away from nanometer scale components and devices. Third, Gorelik simply provides no teaching whatsoever of nanoscale components such as nanoconductors (e.g., nanotubes, nanowires, nanoparticles, etc.) as taught by Applicant's invention. In order for Gorelik to be properly combined with McHardy, both Gorelik and McHardy must provide for a teaching of nanotechnology. In this case, a review of Gorelik reveals that Gorelik does not provide any teaching, suggestion or disclosure of nanometer scale components and devices. The solid state device of McHardy thus cannot be combined the non-nanotechnology based device of Gorelik as argued by the Examiner. There is no hint or teaching in Gorelik or McHardy for combining the non-nanotechnology based device of Gorelik with the solid state electrolytic based device of Gorelik to provide for all of the claim limitations of Applicant's claims (i.e., dielectrophoresis, a dipole-induced connection network, a dielectric medium, nanoconductors disposed in a connection gap in the dielectric medium, and so forth).

Based on the foregoing, the Applicant submits that the rejection to claim 2 has been traversed. The Applicant therefore respectfully requests withdrawal of the aforementioned rejection to claim 2.

Claim 3

The Examiner argued that McHardy teaches wherein the gate of the physical neural network of claim 2 is connected to logic circuitry which can activate or deactivate individual physical synapses among said plurality of physical synapses (the Examiner cited McHardy: C 1-6, particularly C 4, L 55 through C 5, L 9; and argued that some control mechanism is "inherent" to controlling this 'controlled forgetfulness' as applied to 'specific synaptic connections').

The Applicant respectfully disagrees with this assessment and submits that the arguments presented above against the rejection to claims 1 and 17 under 35 U.S.C. 102 apply equally against the rejection to claim 3 under 35 U.S.C. 103 based on McHardy/Gorelik. The Applicant notes that C 1-6 and particularly C 4, L 55 through C 5, L 9 provide no hint, disclosure or suggestion as to how the logic circuitry of Gorelik can be combined with a nanometer-scale device to provide for the essential nanotechnology-based claim limitations of claim 3. There are several reasons why Gorelik cannot properly be combined with McHardy as argued by the Examiner. First, the Examiner asserted that Gorelik is from the same field of endeavor as McHardy. The Applicant asserted earlier that McHardy does not teach, disclose or suggest nanotechnology as taught by Applicant's invention. Second, even if, however, McHardy does teach nanotechnology, it is clear that Gorelik does not teach nanotechnology and in fact teaches away from nanometer scale components and devices. Third, Gorelik simply provides no teaching whatsoever of nanoscale components such as nanoconductors (e.g., nanotubes, nanowires, nanoparticles, etc.) as taught by Applicant's invention. In order for Gorelik to be properly combined with McHardy, both Gorelik and McHardy must provide for a

teaching of nanotechnology. In this case, a review of Gorelik reveals that Gorelik does not provide any teaching, suggestion or disclosure of nanometer scale components and devices. The solid state device of McHardy thus cannot be combined the non-nanotechnology based device of Gorelik as argued by the Examiner. There is no hint or teaching in Gorelik or McHardy for combining the non-nanotechnology based device of Gorelik with the solid state electrolytic based device of Gorelik to provide for all of the claim limitations of Applicant's claims (i.e., dielectrophoresis, a dipole-induced connection network, a dielectric medium, nanoconductors disposed in a connection gap in the dielectric medium, and so forth).

Based on the foregoing, the Applicant submits that the rejection to claim 3 has been traversed. The Applicant therefore respectfully requests withdrawal of the aforementioned rejection to claim 3.

Claim 4

The Examiner argued that McHardy teaches wherein the gate of the physical neural network of claim 2 is connected to logic circuitry which can activate or deactivate groups of physical synapses of said plurality of physical synapses. (the Examiner cited McHardy: C 1-6, particularly C 4, L 55 through C 5, L 9; and argued that some control mechanism is "inherent" to controlling this 'controlled forgetfulness' as applied to a 'low level back bias to all connections,' constituting a group).

The Applicant respectfully disagrees with this assessment and submits that the arguments presented above against the rejection to claims 1 and 17 under 35 U.S.C. 102 apply equally against the rejection to claim 4 under 35 U.S.C. 103 based on McHardy/Gorelik. There are several reasons why Gorelik cannot properly be combined with McHardy as argued by the Examiner. First, the Examiner asserted that Gorelik is from the same field of endeavor as McHardy. The Applicant asserted

earlier that McHardy does not teach, disclose or suggest nanotechnology as taught by Applicant's invention. Second, even if, however, McHardy does teach nanotechnology, it is clear that Gorelik does not teach nanotechnology and in fact teaches away from nanometer scale components and devices. Third, Gorelik simply provides no teaching whatsoever of nanoscale components such as nanoconductors (e.g., nanotubes, nanowires, nanoparticles, etc.) as taught by Applicant's invention. In order for Gorelik to be properly combined with McHardy, both Gorelik and McHardy must provide for a teaching of nanotechnology. In this case, a review of Gorelik reveals that Gorelik does not provide any teaching, suggestion or disclosure of nanometer scale components and devices. The solid state device of McHardy thus cannot be combined the non-nanotechnology based device of Gorelik as argued by the Examiner. There is no hint or teaching in Gorelik or McHardy for combining the non-nanotechnology based device of Gorelik with the solid state electrolytic based device of Gorelik to provide for all of the claim limitations of Applicant's claims (i.e., dielectrophoresis, a dipole-induced connection network, a dielectric medium, nanoconductors disposed in a connection gap in the dielectric medium, and so forth).

Based on the foregoing, the Applicant submits that the rejection to claim 4 has been traversed. The Applicant therefore respectfully requests withdrawal of the aforementioned rejection to claim 4.

Claim 5

The Examiner admitted that McHardy fails to teach that the electrically conducting nanoconnections comprise semiconducting molecular structures. The Examiner stated that they are purely conducting structures in McHardy.

The Examiner argued that Gorelik teaches wherein the electrically conducting nanoconnections comprise semiconducting molecular structures. (The Examiner cited Gorelik: C 8 L 54 through C 10, L 63, where it discusses the charge carrying

semiconductor device, and argued that this comprises semi-conducting molecular connections; the Examiner also cited specification @ p22:1-3, nanoconductor ... nanotechnology ..and argued that this can be implemented as a molecule or groups of molecules).

The Examiner therefore asserted that it would have been obvious to one of ordinary skill at the time of applicant's invention to combine McHardy's and Gorelik's invention for the reasons stated above (the Examiner referred to section: Claim 2).

The Applicant respectfully disagrees with this assessment and submits that the arguments presented above against the rejection to claims 1 and 17 under 35 U.S.C. 102 apply equally against the rejection to claim 5 under 35 U.S.C. 103 based on McHardy/Gorelik. There are several reasons why Gorelik cannot properly be combined with McHardy as argued by the Examiner. First, the Examiner asserted that Gorelik is from the same field of endeavor as McHardy. The Applicant asserted earlier that McHardy does not teach, disclose or suggest nanotechnology as taught by Applicant's invention. Second, even if, however, McHardy does teach nanotechnology, it is clear that Gorelik does not teach nanotechnology and in fact teaches away from nanometer scale components and devices. Third, Gorelik simply provides no teaching whatsoever of nanoscale components such as nanoconductors (e.g., nanotubes, nanowires, nanoparticles, etc.) as taught by Applicant's invention. In order for Gorelik to be properly combined with McHardy, both Gorelik and McHardy must provide for a teaching of nanotechnology. In this case, a review of Gorelik reveals that Gorelik does not provide any teaching, suggestion or disclosure of nanometer scale components and devices. The solid state device of McHardy thus cannot be combined the non-nanotechnology based device of Gorelik as argued by the Examiner. There is no hint or teaching in Gorelik or McHardy for combining the <u>non-nanotechnology</u> based device of Gorelik with the <u>solid state electrolytic</u> based device of Gorelik to provide for all of the claim limitations of Applicant's claims (i.e., dielectrophoresis, a dipole-induced connection network, a

dielectric medium, nanoconductors disposed in a connection gap in the dielectric medium, and so forth).

Based on the foregoing, the Applicant submits that the rejection to claim 5 has been traversed. The Applicant therefore respectfully requests withdrawal of the aforementioned rejection to claim 5.

Claim 6

The Examiner admitted that McHardy fails to teach that the semi-conducting molecular structures comprise semi-conducting nanotubes.

The Examiner argued that Gorelik teaches wherein the semi-conducting molecular structures comprise semi-conducting nanotubes (the Examiner cited Gorelik: C 8 L 54 through C 10, L 63, where it discusses the charge carrying semiconductor device, which comprises semi-conducting molecular connections).

The Examiner argued that it would have been obvious to one of ordinary skill at the time of applicant's invention to combine McHardy's and Gorelik's invention for the reasons stated above (the Examiner referred to section: Claim 2). The Applicant respectfully disagrees with this assessment and submits that the arguments presented above against the rejection to claims 1 and 17 under 35 U.S.C. 102 apply equally against the rejection to claim 6 under 35 U.S.C. 103 based on McHardy/Gorelik. There are several reasons why Gorelik cannot properly be combined with McHardy as argued by the Examiner. First, the Examiner asserted that Gorelik is from the same field of endeavor as McHardy. The Applicant asserted earlier that McHardy does not teach, disclose or suggest nanotechnology as taught by Applicant's invention. Second, even if, however, McHardy does teach nanotechnology, it is clear that Gorelik does not teach nanotechnology and in fact teaches away from nanometer scale components and devices. Third, Gorelik simply provides no teaching whatsoever of nanoscale components such as nanoconductors (e.g., nanotubes, nanowires, nanoparticles, etc.) as taught by Applicant's invention.

In order for Gorelik to be properly combined with McHardy, both Gorelik and McHardy must provide for a teaching of nanotechnology. In this case, a review of Gorelik reveals that Gorelik does not provide any teaching, suggestion or disclosure of nanometer scale components and devices. The solid state device of McHardy thus cannot be combined the non-nanotechnology based device of Gorelik as argued by the Examiner. There is no hint or teaching in Gorelik or McHardy for combining the non-nanotechnology based device of Gorelik with the solid state electrolytic based device of Gorelik to provide for all of the claim limitations of Applicant's claims (i.e., dielectrophoresis, a dipole-induced connection network, a dielectric medium, nanoconductors disposed in a connection gap in the dielectric medium, and so forth).

It is also significant to note that Gorelik at C 8 L 54 through C 10, L 63, where it discusses the charge carrying semiconductor device, does not provide any teaching, suggestion or disclosure of nanotubes and/or nanotechnology, despite the arguments by the Examiner to the contrary. Nanotubes constitute a particular type of nanometer scale nanoconductor. A nanotube is a nanometer scale wire-like structure that is most often composed of carbon, such as, for example carbon nanotubes; however, inorganic nanotubes have also been synthesized, such as, for example, boron nitride nanotubes and silicon nanotubes.

Carbon nanotubes (CNTs), for example, are an allotrope of carbon. They take the form of cylindrical carbon molecules and have novel properties that make them potentially useful in a wide variety of applications in nanotechnology, electronics, optics and other fields of materials science. They exhibit extraordinary strength and unique electrical properties, and are efficient conductors of heat.

Nanotubes are members of the fullerene structural family, which also includes buckyballs. Whereas buckyballs are spherical in shape, a nanotube is cylindrical, with at least one end typically capped with a hemisphere of the buckyball structure. Their name is derived from their size, since the diameter of a nanotube is typically

on the order of a few nanometers (e.g., approximately 50,000 times smaller than the width of a human hair). There are two main types of nanotubes: single-walled nanotubes (SWNTs) and multi-walled nanotubes (MWNTs).

Regardless of the type of nanotubes utilized, it is clear that nanotubes as described above are simply not suggested, taught or disclosed by Gorelik at C 8 L 54 through C 10, L 63 or any other portion of Gorelik. There is simply no suggestion of the use of nanotubes in Gorelik or any hint or suggestion that Gorelik could even reasonably be adapted to modified to include the use of nanotubes. It is not even believed there is even a reasonable success for such a modification of Gorelik, given the fact that Gorelik does not even provide even a hint or suggestion of nanotubes.

Based on the foregoing, the Applicant submits that the rejection to claim 6 has been traversed. The Applicant therefore respectfully requests withdrawal of the aforementioned rejection to claim 6.

Based on the foregoing, the Applicant submits that the rejection to claim 6 has been traversed. The Applicant therefore respectfully requests withdrawal of the aforementioned rejection to claim 6.

Claim 7

The Examiner admitted that McHardy fails to teach that the semi-conducting molecular structures comprises semi-conducting nanowires.

The Examiner argued that Gorelik teaches wherein the semi-conducting molecular structures comprise semi-conducting nanowires (the Examiner cited Gorelik: C 8 L 54 through C 10, L 63, and cited it where it discusses the charge carrying semiconductor device, are argued that this comprises semi-conducting molecular connections).

The Examiner argued that It would have been obvious to one of ordinary skill at the time of applicant's Invention to combine McHardy's and Gorelik's invention for the reasons stated above (the Examiner cited section: Claim 2).

The Applicant respectfully disagrees with this assessment and submits that the arguments presented above against the rejection to claims 1 and 17 under 35 U.S.C. 102 apply equally against the rejection to claim 7 under 35 U.S.C. 103 based on McHardy/Gorelik. There are several reasons why Gorelik cannot properly be combined with McHardy as argued by the Examiner. First, the Examiner asserted that Gorelik is from the same field of endeavor as McHardy. The Applicant asserted earlier that McHardy does not teach, disclose or suggest nanotechnology as taught by Applicant's invention. Second, even if, however, McHardy does teach nanotechnology, it is clear that Gorelik does not teach nanotechnology and in fact teaches away from nanometer scale components and devices. Third, Gorelik simply provides no teaching whatsoever of nanoscale components such as nanoconductors (e.g., nanotubes, nanowires, nanoparticles, etc.) as taught by Applicant's invention. In order for Gorelik to be properly combined with McHardy, both Gorelik and McHardy must provide for a teaching of nanotechnology. In this case, a review of Gorelik reveals that Gorelik does not provide any teaching, suggestion or disclosure of nanometer scale components and devices. The solid state device of McHardy thus cannot be combined the <u>non-nanotechnology</u> based device of Gorelik as argued by the Examiner. There is no hint or teaching in Gorelik or McHardy for combining the <u>non-nanotechnology</u> based device of Gorelik with the <u>solid state electrolytic</u> based device of Gorelik to provide for all of the claim limitations of Applicant's claims (i.e., dielectrophoresis, a dipole-induced connection network, a dielectric medium, nanoconductors disposed in a connection gap in the dielectric medium, and so forth).

It is also important to note that Gorelik at C 8 L 54 through C 10, L 63 provides no teaching, hint or suggestion of nanowires as taught by Applicant's

invention, in addition to no teaching or suggestion of nanotechnology. Where are nanometer-scale components such as nanoconductors taught and suggested by Gorelik? This is also true of nanowires. What is a nanowire? A nanowire is a wire of dimensions of the order of, for example, a nanometer (10^{-9} meters). Nanowires can also be defined as structures that have a lateral size constrained to tens of nanometers or less and an unconstrained longitudinal size. At these scales, quantum mechanical effects are important — hence such wires are also known as "quantum wires". Many different types of nanowires exist, including metallic (e.g., Ni, Pt, Au), semiconducting (e.g., InP, Si, GaN, etc.), and insulating (e.g., SiO_2,TiO_2). Molecular nanowires are composed of repeating molecular units either organic (e.g. DNA) or inorganic (e.g. $Mo_6S_{9-x}I_x$). Such components are clearly not suggested, disclosed and/or taught by Gorelik at C 8 L 54 through C 10, L 63 or any other portion of Gorelik.

Based on the foregoing, the Applicant submits that the rejection to claim 7 has been traversed. The Applicant therefore respectfully requests withdrawal of the aforementioned rejection to claim 7.

Claim 8

Regarding claim 8, the Examiner admitted that McHardy fails to teach that the semi-conducting molecular structures comprise semi-conducting nanoparticles. The Examiner argued that they are purely conducting structures in McHardy.

The Examiner asserted that Gorelik teaches wherein the semi-conducting molecular structures comprise semi-conducting nanoparticles. (Gorelik: C 8 L 54 through C 10, L 63, where it discusses the charge carrying semiconductor device, which comprises semi-conducting molecular connections. Nanoparticles are the atoms and molecules maintaining the connections at the nanometer scale, such as the atoms at the border of the n-type and p-type wells common in semi-conducting devices).

The Applicant respectfully disagrees with this assessment. The atoms such as at the border of the n-type and p-type wells common in semi-conducting devices are not "nanoparticles" such as those taught by Applicant's invention. Applicant's nanoparticles are semi-conducting structures at the nanometer scale, but are also subject to the definition of nanotechnology as taught by Applicant's invention. With this definition in mind, it is clear that the atoms at the border of the n-type and p-type wells common in semi-conducting devices are not "nanoparticles" as taught by Applicant's invention.

As indicated previously, a nanoconductor as taught by Applicant's invention is thus a multi-atom structure such as a nanotube, a nanowire, DNA, etc., and not atoms and ions. Atoms and ions, for example, are simply just that...i.e., atoms and ions. The Applicant's use of nanotechnology-based devices and components relates to multi-atom structures that are built (man-made or natural) or synthesized. DNA, for example, is a naturally constructed multi-atom structure. Free floating ions and atoms utilized for example in the context of common P-well and N-well configurations are not such structures. Atoms and atomic ions do not represent nanoparticles/nanoconductors because "nanotechnology" seeks to use atoms as the building blocks of multi-atom structures. Thus, atoms and molecules maintaining the connections at the nanometer scale, such as the atoms at the border of the n-type and p-type wells common in semi-conducting devices, do not suggest, teach, or disclose semi-conducting nanoconductors such as the nanoparticles, nanotubes, nanowires and DNA of Applicant's invention.

The Examiner additionally argued that it would have been obvious to one of ordinary skill at the time of applicant's invention to combine McHardy's and Gorelik's invention for the reasons stated above (the Examiner referred to section: Claim 2).

The Applicant respectfully disagrees with this assessment and submits that the arguments presented above against the rejection to claims 1 and 17 under 35 U.S.C. 102 apply equally against the rejection to claim 7 under 35 U.S.C. 103 based

on McHardy/Gorelik. There are several reasons why Gorelik cannot properly be combined with McHardy as argued by the Examiner. First, the Examiner asserted that Gorelik is from the same field of endeavor as McHardy. The Applicant asserted earlier that McHardy does not teach, disclose or suggest nanotechnology as taught by Applicant's invention. Second, even if, however, McHardy does teach nanotechnology, it is clear that Gorelik does not teach nanotechnology and in fact teaches away from nanometer scale components and devices. Third, Gorelik simply provides no teaching whatsoever of nanoscale components such as nanoconductors (e.g., nanotubes, nanowires, nanoparticles, etc.) as taught by Applicant's invention. In order for Gorelik to be properly combined with McHardy, both Gorelik and McHardy must provide for a teaching of nanotechnology. In this case, a review of Gorelik reveals that Gorelik does not provide any teaching, suggestion or disclosure of nanometer scale components and devices. The solid state device of McHardy thus cannot be combined the non-nanotechnology based device of Gorelik as argued by the Examiner. There is no hint or teaching in Gorelik or McHardy for combining the non-nanotechnology based device of Gorelik with the solid state electrolytic based device of Gorelik to provide for all of the claim limitations of Applicant's claims (i.e., dielectrophoresis, a dipole-induced connection network, a dielectric medium, nanoconductors disposed in a connection gap in the dielectric medium, and so forth).

Based on the foregoing, the Applicant submits that the rejection to claim 8 has been traversed. The Applicant therefore respectfully requests withdrawal of the aforementioned rejection to claim 8.

McHardy in view of Nunally

Claims 11-13 were rejected under 35 U.S.C. 103(a) as being unpatentable over McHardy as applied to claims 1 and 9 above, and further in view of Nunally (US Patent 5,615,30, herein referred to as Nunally).

Claim 11

The Examiner admitted that McHardy fails to teach that the physical neural network wherein at least one generated pulse from said at least one pre-synaptic electrode and at least one generated pulse from said at least one post-synaptic electrode is determinative of synaptic update values thereof.

The Examiner argued that Nunally teaches that at least one generated pulse from said at least one presynaptic electrode and at least one generated pulse from said at least one post-synaptic electrode is determinative of synaptic update values thereof (the Examiner cited Nunally: C 1-7, particularly C 4, L 58 through C 5, L 8).

The Examiner asserted that being from the same field of endeavor, physical neurons (of artificial neural systems) and synapses thereof to mimic the behavior of biological neurons, it would have been obvious to one of ordinary skill at the time of applicant's invention to combine McHardy's electrochemical synapse which provides easy miniaturization of the vast amounts of neurons needed to simulate biological neurons with Nunally's pulse driven training mechanism to be able to update vast amounts of synaptic weights of the network asynchronously with little computational requirements (the Examiner cited Nunally: C 1, L 53-67 in support of this argument).

The Applicant respectfully disagrees with this assessment and submits that the arguments presented above against the rejection to claims 1 and 17 under 35 U.S.C. 102 apply equally against the rejection to claim 11 under 35 U.S.C. 103 based on McHardy/Nunally. There are several reasons why Nunally cannot properly be combined with McHardy as argued by the Examiner. First, the Examiner asserted that Nunally is from the same field of endeavor as McHardy. The Applicant asserted earlier that McHardy does not teach, disclose or suggest nanotechnology as taught by Applicant's invention. Second, even if, however, McHardy does teach nanotechnology, it is clear that Nunally does not teach nanotechnology and in fact

teaches away from nanometer scale components and devices. Third, Nunally simply provides no teaching whatsoever of nanoscale components such as nanoconductors (e.g., nanotubes, nanowires, nanoparticles, etc.) as taught by Applicant's invention. In order for Nunally to be properly combined with McHardy, both Nunally and McHardy must provide for a teaching of nanotechnology, not just one of the references. In this case, a review of Nunally reveals that Nunally does not provide any teaching, suggestion or disclosure of nanometer scale components and devices. The various MOSFET, PMOS, NMOS, and other components taught by Nunally are clearly NOT nanometer scale components. Nunally is thus a non-nanotechnology based device. The solid state device of McHardy thus cannot be combined the non-nanotechnology based device of Nunally as argued by the Examiner because the use of the non-nanotechnology based device of Nunally teaches away from such a combination. There is no hint or teaching in Nunally or McHardy for combining the non-nanotechnology based device of Nunally with the solid state electrolytic based device of Nunally to provide for all of the claim limitations of Applicant's claims (i.e., dielectrophoresis, a dipole-induced connection network, a dielectric medium, nanoconductors disposed in a connection gap in the dielectric medium, and so forth).

Nunally at C 1-7, particularly C 4, L 58 through C 5, L 8, does not provide for any teaching of nanometer scale components or devices. If McHardy is a nanotechnology based invention as the Examiner argued, then Nunally in order to be "from the same field of endeavor" must also provide some teaching of nanotechnology, which it does not. Thus, Nunally and McHardy cannot be combined as argued by the Examiner. It is also significant to note that both Nunally and McHardy teach solid state devices and components and not the use of a liquid, such as the liquid dielectric solution of Applicant's invention.

Based on the foregoing, the Applicant submits that the rejection to claim 11 has been traversed. The Applicant therefore respectfully requests withdrawal of the aforementioned rejection to claim 11.

Claim 12

The Examiner admitted that McHardy fails to teach the neural network of claim 9 wherein a shape of at least one generated pulse from said at least one pre-synaptic electrode and at least one generated pulse from said at least one post-synaptic electrode is determinative of synaptic update values thereof.

The Examiner asserted that Nunally teaches a shape of at least one generated pulse from said at least one pre-synaptic electrode and at least one generated pulse from said at least one postsynaptic electrode is determinative of synaptic update values thereof. (the Examiner cited Nunally: C 1-7, particularly C 2, L 40-46 as well as C 4, L 1-021 in support of this argument).

The Examiner argued that it would have been obvious to one of ordinary skill at the time of applicant's invention to combine McHardy's and Nunally's invention for the reasons stated above (the Examiner cited section: Regarding Claim 12).

The Applicant respectfully disagrees with this assessment and submits that the arguments presented above against the rejection to claims 1 and 17 under 35 U.S.C. 102 apply equally against the rejection to claim 12 under 35 U.S.C. 103 based on McHardy/Nunally. There are several reasons why Nunally cannot properly be combined with McHardy as argued by the Examiner. First, the Examiner asserted that Nunally is from the same field of endeavor as McHardy. The Applicant asserted earlier that McHardy does not teach, disclose or suggest nanotechnology as taught by Applicant's invention. Second, even if, however, McHardy does teach nanotechnology, it is clear that Nunally does not teach nanotechnology and in fact teaches away from nanometer scale components and devices. Third, Nunally simply provides no teaching whatsoever of nanoscale components such as nanoconductors

(e.g., nanotubes, nanowires, nanoparticles, etc.) as taught by Applicant's invention. In order for Nunally to be properly combined with McHardy, both Nunally and McHardy must provide for a teaching of nanotechnology, not just one of the references. In this case, a review of Nunally reveals that Nunally does not provide any teaching, suggestion or disclosure of nanometer scale components and devices. The various MOSFET, PMOS, NMOS, and other components taught by Nunally are clearly NOT nanometer scale components. Nunally is thus a non-nanotechnology based device. The solid state device of McHardy thus cannot be combined the non-nanotechnology based device of Nunally as argued by the Examiner because the use of the non-nanotechnology based device of Nunally teaches away from such a combination. There is no hint or teaching in Nunally or McHardy for combining the non-nanotechnology based device of Nunally with the solid state electrolytic based device of Nunally to provide for all of the claim limitations of Applicant's claims (i.e., dielectrophoresis, a dipole-induced connection network, a dielectric medium, nanoconductors disposed in a connection gap in the dielectric medium, and so forth).

Based on the foregoing, the Applicant submits that the rejection to claim 12 has been traversed. The Applicant therefore respectfully requests withdrawal of the aforementioned rejection to claim 12.

Claim 13

The Examiner admitted that McHardy fails to teach an adaptive neural network which is trainable based on said at least one generated pulse across said at least one pre-synaptic electrode and at least one generated pulse across said at least one post-synaptic electrode.

The Examiner argued that Nunally teaches an adaptive neural network which is trainable based on said at least one generated pulse across said at least one pre-synaptic electrode and at least one generated pulse across said at least one post-

synaptic electrode (the Examiner cited Nunally: C 1-7, particularly C 4, L 58 through C 5, L 8 in support of this argument).

The Examiner argued that it would have been obvious to one of ordinary skill at the time of Applicant's invention to combine McHardy's and Nunally's invention for the reasons stated above (the Examiner cited section: Claim 12).

The Applicant respectfully disagrees with this assessment and submits that the arguments presented above against the rejection to claims 1 and 17 under 35 U.S.C. 102 apply equally against the rejection to claim 13 under 35 U.S.C. 103 based on McHardy/Nunally. There are several reasons why Nunally cannot properly be combined with McHardy as argued by the Examiner. First, the Examiner asserted that Nunally is from the same field of endeavor as McHardy. The Applicant asserted earlier that McHardy does not teach, disclose or suggest nanotechnology as taught by Applicant's invention. Second, even if, however, McHardy does teach nanotechnology, it is clear that Nunally does not teach nanotechnology and in fact teaches away from nanometer scale components and devices. Third, Nunally simply provides no teaching whatsoever of nanoscale components such as nanoconductors (e.g., nanotubes, nanowires, nanoparticles, etc.) as taught by Applicant's invention. In order for Nunally to be properly combined with McHardy, <u>both</u> Nunally and McHardy must provide for a teaching of nanotechnology, not just one of the references. In this case, a review of Nunally reveals that Nunally does not provide any teaching, suggestion or disclosure of nanometer scale components and devices. The various MOSFET, PMOS, NMOS, and other components taught by Nunally are clearly NOT nanometer scale components. Nunally is thus a non-nanotechnology based device. The solid state device of McHardy thus cannot be combined the <u>non-nanotechnology</u> based device of Nunally as argued by the Examiner because the use of the non-nanotechnology based device of Nunally teaches away from such a combination. There is no hint or teaching in Nunally or McHardy for combining the <u>non-nanotechnology</u> based device of Nunally with the <u>solid state</u> <u>electrolytic</u> based

device of Nunally to provide for all of the claim limitations of Applicant's claims (i.e., dielectrophoresis, a dipole-induced connection network, a dielectric medium, nanoconductors disposed in a connection gap in the dielectric medium, and so forth).

Based on the foregoing, the Applicant submits that the rejection to claim 13 has been traversed. The Applicant therefore respectfully requests withdrawal of the aforementioned rejection to claim 13.

McHardy in view of Widrow

Claim 16 was rejected under 35 U.S.C. 103(a) as being unpatentable over McHardy as applied to claims 1 above, and further in view of Widrow (US Patent 3,222,654, herein referred to as Widrow).

Claim 16

The Examiner admitted that McHardy fails to teach the physical neural network of claim 1 wherein a variable increase in a frequency of said electrical field across said connection gap strengthens said nanoconductors within said dielectric liquid solution.

The Examiner argued that Widrow teaches a variable increase in a frequency of said electrical field across said connection gap strengthens said nanoconductors within said dielectric liquid solution (the Examiner cited Widrow: C 10, L 65 through C 11, L 10; and argued that the ability of the memistor to be used as a multiplier or a linear modulator with the appropriate addition of copper circuitry; an increase in frequency f, corresponds to the increase in the connection gap strength). The Examiner argued that changing the frequency of the alternating current is still within the scope of the disclosed alternating current of Widrow, which is in direct correlation to the rate of deposition of the electroplating.

The Examiner argued that being from the same field of endeavor, physical neurons (of artificial neural systems) and synapses thereof to mimic the behavior of biological neurons, it would have been obvious to one of ordinary skill at the time of applicant's invention to combine McHardy's electrochemical (nanoconductors in a dielectric liquid solution) synapse which provides easy miniaturization of the vast amounts of neurons needed to simulate biological neurons with Widrow's method of electrochemical plating. The Examiner argued that McHardy can be seen as a closer approximation to the current state of the art offering miniaturization and thus the ability to use many of these neurons in parallel with little worry for space constraint.

The Applicant respectfully disagrees with this assessment and submits that the arguments presented above against the rejection to claims 1 and 17 under 35 U.S.C. 102 apply equally against the rejection to claim 16 under 35 U.S.C. 103 based on McHardy/Widrow.

Applicant refers the Examiner to the earlier presented discussion regarding what "nanotechnology" is and what it is not. As such, Widrow clearly does not provide for any teaching or suggestion of nanotechnology and the use of nanotechnology-based nanoconductors such as nanotubes, nanowires, DNA, etc. The Applicant also notes that "nanotechnology" as the field of art is known was not even around at the time (1961) that the Widrow patent was issued. It is well known that the use of the word "nanotechnology" did not begin until at least the 1980's and generally stems from the writings of Eric Drexler, author of the well known nanotechnology text, "Engines of Creation". In the late 1970's, Eric Drexler began to invent what would become molecular manufacturing. He quickly realized that molecular machines could control the chemical manufacture of complex products, including additional manufacturing systems-which would be a very powerful technology. Drexler published scientific papers beginning in 1981. In 1986 he introduced the term "nanotechnology" in his book *Engines of Creation* to describe this approach to manufacturing and some of its consequences.

(Subsequent search showed that Taniguchi had previously used the word "nano-technology" in Japan to describe precision micromachining.) In any event, "nanotechnology" as the field is now known today was not even around in 1961 when the Widrow device was patented.

Thus, Widrow is certainly not a "nanotechnology" based device and it would not make sense to combine a non-nanotechnology based device with another device or reference to argue an overall teaching of nanotechnology. The Widrow reference does not suggest, disclose, or teach any nanometer scale components whatsoever. The Examiner argued that McHardy teaches nanoconductors in a dielectric liquid solution. This is not true. There is no dielectric liquid solution in McHardy and/or in Widrow.

Beyond the fact that Widrow is not even a nanotechnology-based reference and provides no hint or suggestion or motivation for combining it with another reference to teach nanotechnology, Widrow and Applicant's invention are very different from one another in a number of other respects. There are many other factors that come into play, which are not taught, anticipated or suggested by Widrow for differentiating Widrow from Applicant's invention. One of these factors is the use of a dielectric medium in which Applicant's nanoconductors are located as a part of the overall physical neural network. Widrow refers to the use of an electrolytic memory element. The key word here is electrolytic, because in fact, Widrow is based on electrolytic principals, while Applicant's invention is based on the use of a dielectric medium. This a significant difference, particularly in light of the fact that there is simply no teaching, suggestion or disclosure in Widrow of a dielectric medium in which nanoconductors are disposed (nor any teaching whatsoever in Widrow of nanoconductors).

An electrolytic medium such as that of Widrow is not a dielectric medium: one exists for the movement of ions to promote electrical conduction (electrolytic); the other is used specifically for its properties of canceling electric fields, and more

importantly to the Applicant's invention, for inhibiting electrical conduction (i.e., dielectric). An electrolytic medium involves the use of an electrolyte and not a dielectric. Widrow provides no teaching, suggestion or disclosure of the use of such a dielectric medium as taught by Applicant's invention.

An electrolyte is a substance containing free ions which behaves as an electrically conductive medium. A dielectric, on the other hand, is basically an electrical insulator, and constitutes a substance that is highly resistant to electric current.. Unlike an electrolyte, a dielectric tends to concentrate an applied electric field within itself. As the dielectric interacts with the applied electric field, charges are redistributed within the atoms or molecules of the dielectric. This redistribution alters the shape of the applied electric field both inside and in the region near the dielectric material. It is this process, when taken with the affects of nanoparticles also displaying a dielectric behavior, which causes a dipole-induced force to attract the particles to the connection gap. For example, refer to paragraph of [0098] of Applicant's invention where it is stated that "...The only general requirements for the conducting material utilized to configure the nanoconductors are that such conducting material must conduct electricity, and a dipole should preferably be induced in the material when in the presence of an electric field."

The use of a dielectric medium (not an electrolyte) as taught by Applicant's invention is dielectrophoresis, as explained previously. The use of a dipole-induced force and dielectrophoresis are features that are not taught, suggested or disclosed by Widrow. In particular, there is no teaching or suggestion of a dielectric medium for growing nanoconnections in Windrow. In fact, Widrow at C1:10-14 refers to logic circuits and memory elements, but provides for no teaching and/or disclosure of a dielectric medium. C2:40-48 of Widrow, for example, provides for no teaching and/or disclosure of a dielectric medium, but instead refers only to various logic circuits in Widrow's figures. Additionally, C3:18-28 of Widrow refers only to components of an adaptive logic circuit, but again provides no hint or disclosure of

the use of a dielectric medium as taught by Applicant's invention. The lack in Widrow of the teaching or disclosure of a critical component such as a dielectric medium is very significant.

In addition to the lack of a disclosure, teaching and/or suggestion in Widrow of the use of a dielectric medium and nanoconductors disposed in such a dielectric medium, Widrow also teaches a device based on the concept of electroplating. (See, for example, Col. 2, lines 13-16 and Col. 4, lines 34-55 of Widrow). The Widrow apparatus is a chemical device whose foundation is the process of electroplating. The use of electroplating is an electrochemical process, which stands in stark contrast to Applicant's device, which is based on an electromechanical process/system (i.e., nanoconductors in a dielectric liquid medium and subject to a dielectrophoretic force).

The Widrow devices utilizes the electrochemical process of electroplating to achieve its operations. The chemical process is fundamental to its operation and described in detail throughout the Widrow patent and stated as a limiting aspect of the invention in every single claim. For example, claim 1 of Widrow refers repeatedly to the use of an electrolyte and electroplating.

By stark contrast, the Applicant's invention is ***electromechanical***. No chemical bonds are broken nor made during device operation. The dipole-induced force described earlier with respect to Applicant's invention acts to accumulate particles between electrodes to facilitate electrical conduction.

Widrow simply fails to teach the use of a dielectrophoretic force, a dielectric medium and nanoconductors disposed in such a dielectric medium, wherein such nanoconductors form neural network connections in the dielectric medium. The device of Widrow is limited to the use of the electrochemical process/apparatus of electroplating/electrolytes. The Applicant's invention, on the other hand, may use nanoconductors such as carbon nanotubes, gold nanowires, gold nanoparticles, latex spheres, DNA, etc. In the Applicant's invention, an electric field affects such

nanoconductors by inducing a dipole force. That is, as explained previously, the dipole is induced in the nanoparticle/nanoconductor, which in turn causes a force towards regions of high field gradient such as the connection gap described and claimed by Applicant. Note that the direction of a dipole induced force is not necessarily the direction of the applied electric field. The electrical conduction between electrodes that form the electrode gap (i.e., connection gap) can be regulated by the presence of nanoparticles (i.e., nanoconductors) at or near the connection gap. This process is thus electro**mechanical**.

Another significant difference between Widrow and Applicant's invention is that Widrow is a three-terminal device and Applicant's invention is a two-terminal device. See, for example, FIG. 16 of Widrow, where a three-terminal configuration is illustrated. The difference between a three-terminal device and a two-terminal device is significant in building large adaptive systems. In order to assist the Examiner in appreciating this difference, we provide the following discussion. Imagine two electrical devices - device 1 and device 2. Device 1 is composed of three-terminals, which we will call terminals A, B, C. The conductance between terminal A and C is a function of the voltage of terminal B. In other words, by applying a certain voltage to terminal B, we may increase the conductance between terminals A and C. By applying an opposite voltage, we may weaken the conductance between terminals A and C. Now, picture the second device, device 2, which only has two terminals, which we will refer to as A and C. The conductance between terminals A and C of device 2 is a function of the accumulation of voltage over time between terminals A and C. Now, to make clear how these two devices are used, we can say the following: for device 1, the conductance between terminals A and C is a function of what we do to terminal B; for device 2, the conductance between terminals A and C of device 2 is a function of how we use terminals A and C. Device 2 implies adaptability whereas device 1 implies set-ability.

To put this into a practical perspective, let us assume that device 1 and device 2 occupy equal volumes. Let us further assume that we are trying to build a highly interconnected system on the order of what we see in biological systems (e.g., brains). In this case, we will require on the order of approximately 1 quadrillion (i.e., a million billion) devices, where such devices are equivalent to a synaptic junction. Disregarding the volume taken up by neurons and the wires connecting the synapses, at a bare minimum we know that the volume occupied by these devices would be a 1 quadrillion multiple of the device volume. Now consider device 1. Because of the three terminal nature of device 1, the device cannot be operated as a standalone adaptive element. Rather, we must now create a second circuit such that this circuit takes as an input the voltages on terminals A and C of device 1 and outputs an appropriate voltage onto the terminal B of device 1. The volume of the device 1 implementation is now much greater because it includes not only the adaptive element but also the circuit for controlling the adaptive element. So, at a bare minimum, in terms of volume occupied and assuming both devices do indeed occupy the same volume, we can say that device 2 system implementation occupies at least half the volume of the device 1 system implementation. Now consider that device 1, which is operationally equivalent to the Widrow device has a dimension on the order of 1 cm and that the Applicant's invention has a dimension on the order of, for example, 50 nanometers.

This three-terminal versus two-terminal difference can be applied to the dimensions provided by Widrow himself. Column 4, lines 59-61 of Widrow indicates that the Widrow substrate is 2 ¾ inches long. Assuming that the Widrow device occupies 1 cubic centimeter, then a system with 1 quadrillion of these Widrow elements would occupy roughly 1 cubic kilometer, which to put in perspective is about the size of a small mountain. But this is only for Widrow's synapse. To take into account the circuitry required to implement adaptability as discussed above, we

would need at least twice this volume. Note that for similar reasons, McHardy is also a three-terminal device.

Now, consider the Applicant's invention, which is based on nanoscale device dimensions. Assuming, for example, that the Applicant's device is around 100 nanometers by 100 nanometers by 10 nanometers, then the volume occupied by 1 quadrillion of Applicant's two-terminal synapses is 10 cm^3, which is roughly the size of a human brain.

There can be no doubt that the Applicant's use of a two-terminal configuration (which is not taught, disclosed or suggested by Widrow and/or McHardy and or the other references) instead of a three-terminal invention (which is taught by Widrow/McHardy) is a significant improvement over Widrow/McHardy and a fundamental difference between Applicant's invention and these other devices.

Based on the foregoing, the Applicant submits that the rejection to claim 16 has been traversed. The Applicant therefore respectfully requests withdrawal of the aforementioned rejection to claim 16.

McHardy, Gorelik, Widrow, Nunally

Claims 20-23 were rejected under 35 U.S.C. 103(a) as being unpatentable over McHardy, in view of Gorelik and in further view of Widrow, and in further view of Nunally.

Claim 20

The Examiner argued that McHardy teaches a physical neural network based on nanotechnology comprising (the Examiner cited McHardy, C 1-6, particularly C 1, L 8-10; also C 2, L 45-54; from specification @ p22:1-3, and argued nanoconductor... nanotechnology.. and further argued that this can be implemented as a molecule or groups of molecules), comprising:

a dipole-induced connection network (the Examiner cited McHardy, Figs. 1, 2; dipole is two poles; neural networks are inherently a connection network, as proper operation requires numerous weighted connections and other requirements); comprising a plurality of electrically conducting nanoconnections suspended and free to move about in a dielectric liquid solution within a connection gap (the Examiner cited McHardy: C 3, L 43-62; Fig. 1) formed between at least one pre-synaptic electrode and at least one post-synaptic electrode (the Examiner cited McHardy: C 1-6, particularly C 1, L 44 through C 2, 54 where it discusses the roles of the anode and the cathode ... pre and post synaptic), wherein at least one molecular connection of said plurality of electrically conducting nanoconnections with said dielectric liquid solution can be strengthened or weakened to an application of an electric field across said connection gap and said at least one pre-synaptic electrode and said at least one post-synaptic electrode (the Examiner cited McHardy: C 1-6, particularly C 1, L 44 through C 2, 54; also C 3, L 44 through C 4, L 7; strengthening or weakening corresponds to the amount of whiskers present in the interconnect channel, likewise the conductivity of that channel)

a plurality of physical synapses of said adaptive physical neural network formed from said nanoconnections (the Examiner cited McHardy: C 1-6, particularly C 2, L 45-54; Fig. 1) and

wherein a resistance of said electrically conducting nanoconnections of said adaptive physical neural network bridging said at least one pre-synaptic electrode and said at least one post-synaptic electrode is a function of a prior electric field across said at least one pre-synaptic electrode and said at least post-synaptic electrode (the Examiner cited McHardy, C 1 L 29 through C 2, L 4 and where it discusses Bernard Widrow's "memistor's" capability to regulate resistance [the Examiner asserted that it does this through the application of an electric field] and also immediately following this discussion where it describes the process of metal migration, and how metallic whiskers grow to create an ohmic [resistive] contact

between electrodes when a DC voltage is applied, the whiskers begin the molecular or nano conducting connections).

The Examiner admitted that McHardy fails to teach wherein the physical neural network comprises a gate located adjacent said connection gap, insulated from electrical contact by an insulation layer, and that the physical neural network wherein a variable increase in a frequency of said electrical field across said connection gap strengthens said electrically conducting nanoconnections of said adaptive physical neural network, and wherein the adaptive neural network is trainable based on said at least one generated pulse across said at least one pre-synaptic electrode and at least one generated pulse across said at least one post-synaptic electrode.

The Examiner argued that Gorelik teaches wherein the physical neural network further comprises a gate located adjacent said connection gap, insulated from electrical contact by an insulation layer (the Examiner cited Gorelik: C 8 L 54 through C 9, L 35).

The Examine argued that being from the same field of endeavor, physical neurons (of artificial neural systems) and synapses thereof to mimic the behavior of biological neurons, it would have been obvious to one of ordinary skill at the time of applicant's invention to combine McHardy's electrochemical synapse which provides easy miniaturization of the vast amounts of neurons needed to simulate biological neurons with Gorelik's semiconducting method of an approximation to an artificial biological neuron with this insulation layer so as to maintain charge within the charge carrying layer indefinitely, thus allowing minimal leakage. (the Examiner cited Gorelik: C 8 L 54 through C 9, L 35). The Examiner argued that combining the electrochemical synapse with a semiconducting signaling device allows for greater flexibility in the application of the physical neural network, where it is to be implemented in different environments for different needs of fault-tolerance or physical structure or electrical requirements.

The Examiner argued that Widrow teaches the ability of the memistor to be used as a multiplier or a linear modulator with the appropriate addition of copper circuitry. (the Examiner cited Widrow: C 10, L 65 through C 11, L 10) The Examiner argued that an increase in frequency f, corresponds to the increase in the connection gap strength. The Examiner also argued that changing the frequency of the alternating current is still with the scope of the disclosed alternating current of Widrow, which is in direct correlation to the rate of deposition of the electroplating.

The Examiner asserted that being from the same field of endeavor, physical neurons (of artificial neural systems) and synapses thereof to mimic the behavior of biological neurons, it would have been obvious to one of ordinary skill at the time of applicant's invention to combine McHardy's electrochemical synapse which provides easy miniaturization of the vast amounts of neurons needed to simulate biological neurons with Widrow's method of electrochemical plating. The Examiner argued that McHardy can be seen as a closer approximation to the current state of the art offering miniaturization and thus the ability to use many of these neurons in parallel with little worry for space constraint.

The Examiner asserted that Nunally teaches an adaptive neural network which is trainable based on said at least one generated pulse across said at least one pre-synaptic electrode and at least one generated pulse across said at least one post-synaptic electrode (the Examiner cited Nunally: C 1-7, particularly C 4, L 58 through C 5, L 8).

The Examiner argued that being from the same field of endeavor, physical neurons (of artificial neural systems) and synapses thereof to mimic the behavior of biological neurons, it would have been obvious to one of ordinary skill at the time of applicant's invention to combine McHardy's electrochemical synapse which provides easy miniaturization of the vast amounts of neurons needed to simulate biological neurons with Nunally's pulse driven training mechanism to be able to update vast amounts of synaptic weights of the network asynchronously with little

computational requirements (the Examiner cited Nunally: C 1, L 53-67 in support of this argument).

The Applicant respectfully disagrees with this assessment and submits that the arguments presented above against the rejection to claims 1 and 17 under 35 U.S.C. 102 apply equally against the rejection to claim 20 under 35 U.S.C. 103. Additionally, all of the arguments presented above against the use of the Nunally, Gorelik and Widrow references apply equally against the rejection to claim 20. The Applicant will not repeat these arguments in the interest of preventing redundancy and in order to simplify this response.

Based on the foregoing, the Applicant submits that the rejection to claim 20 has been traversed. The Applicant therefore respectfully requests withdrawal of the aforementioned rejection to claim 20.

Claim 21

The Examiner admitted McHardy does not teach a gate located adjacent said connection gap, insulated from electrical contact by an insulation layer wherein said gate is connected to logic circuitry which can activate or deactivate individual physical synapses among said plurality of physical synapses or which can activate or deactivate groups of physical synapses of said plurality of physical synapses. (the Examiner cited **Gorelik:** C 8 L 54 through C 9, L 35; C 10, L 29-40; Fig. 2, Fig. 4; and argued that the gate is CCSD 102 can activate/deactivate other synapses).

The Applicant respectfully disagrees with this assessment and submits that the arguments presented above against the rejection to claims 1 and 17 under 35 U.S.C. 102 apply equally against the rejection to claim 21 under 35 U.S.C. 103. Additionally, all of the arguments presented above against the use of the Nunally, Gorelik and Widrow references apply equally against the rejection to claim 21. The Applicant will not repeat these arguments in the interest of preventing redundancy and in order to simplify this response.

Based on the foregoing, the Applicant submits that the rejection to claim 21 has been traversed. The Applicant therefore respectfully requests withdrawal of the aforementioned rejection to claim 21.

III. Conclusion

The Applicant has clarified the structural distinctions of the present invention via the amendments submitted herewith. Applicant respectfully requests the withdrawal of the rejections under 35 U.S.C. §102 and §103 based on the preceding amendments and remarks. Reconsideration and allowance of Applicant's application is respectfully solicited.

Should there be any outstanding matters that need to be resolved, the Examiner is respectfully requested to contact the undersigned representative to conduct an interview in an effort to expedite prosecution in connection with the present application.

Respectfully submitted,

Kermit Lopez

Dated: December 18, 2006

Kermit Lopez
Attorney for Applicants
Registration No. 41,953
ORTIZ & LOPEZ, PLLC
P.O. Box 4484
Albuquerque, NM 87196-4484